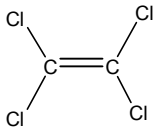
TETRACHLOROETHYLENE (PERCHLOROETHYLENE)
CAS No. 127-18-4
First Listed in the *Fifth Annual Report on Carcinogen*



CARCINOGENICITY

Tetrachloroethylene (perchloroethylene) is *reasonably anticipated to be a human carcinogen* based on sufficient evidence of carcinogenicity in experimental animals (IARC V.20, 1979; NTP 311, 1986; IARC S.7, 1987). When administered by inhalation, tetrachloroethylene increased the incidences of hepatocellular adenomas and carcinomas in male mice and hepatocellular carcinomas in female mice. By the same route of administration, the compound increased the incidences of mononuclear cell leukemia in rats of both sexes and rare renal tubular cell neoplasms in male rats. When administered by gavage, tetrachloroethylene increased the incidence of hepatocellular carcinomas in mice of both sexes.

There are no data available to evaluate the carcinogenicity of tetrachloroethylene in humans. (IARC S.7, 1987; ATSDR, 1995k). Tetrachloroethylene has been studied by observing laundry and dry-cleaning workers, who may also have been exposed to other solvents, especially trichloroethylene, but also petroleum solvents. In several cohort and proportionate mortality studies, excesses have been reported of lymphosarcomas; leukemias; and cancers of the skin, colon, lung and urogenital tract. Some excess of lymphomas and of cancers of the larynx and urinary bladder was seen in a large cohort of dry cleaners. A familial cluster of chronic lymphocytic leukemia has also been related to dry cleaning. Although these studies suggest a possible association between long-term occupational exposure to tetrachloroethylene and increased lymphatic malignancies and urogenital cancers, the evidence must be regarded as inconclusive because workers were exposed to petroleum solvents and other dry cleaning agents as well as tetrachloroethylene.

PROPERTIES

Tetrachloroethylene is a colorless, nonflammable liquid with an ether-like odor. It is miscible with alcohol, ether, chloroform, oils, and benzene but is practically insoluble in water. When heated to decomposition, tetrachloroethylene emits toxic fumes of hydrochloric acid and other chlorinated compounds. It is oxidized by strong oxidizing agents. It is slowly decomposed by light and is sensitive to prolonged exposure to air

USE

Tetrachloroethylene is used primarily in dry cleaning and textile processing (56% of the tetrachloroethylene produced), as a chemical intermediate, mostly in the production of chlorofluorocarbons F-113 and F-114 (29%), and as a metal degreasing agent (11%) (Chem. Mktg. Rep., 1986a; Chem. Week, 1987c). Tetrachloroethylene is also used as an insulating fluid and cooling gas in electrical transformers, as a solvent with various applications, as an extractant for pharmaceuticals, as a pesticide intermediate, and as an anthelmintic agent (IARC V.20, 1979;

ATSDR, 1995k). To a lesser extent, it is used in the production of adhesives, aerosols, paints, and coatings (Morgan et al., 1985).

PRODUCTION

Chemical and Engineering News estimated that 384 million lb of tetrachloroethylene were produced in the United States in 1990 (Chem Eng. News, 1991). The USITC reported that 479 million lb of tetrachloroethylene were produced domestically in 1989 (USITC, 1990). The USITC reported that 497 million lb of tetrachloroethylene were produced domestically in 1988 and 473 million in 1987 (USITC, 1989, 1988). In 1986, the USITC reported that domestic production of tetrachloroethylene was 405 million lb and in 1985, domestic production was 464 million lb (Chem. Week, 1986c; Chem. Mktg. Rep., 1986a). In 1984, estimated production by 5 producers was 573 million lb, of which 434 million lb were sold (USITC, 1985). In 1983, 547 million lb of tetrachloroethylene were produced (Chem. Prod., 1985c).

Total tetrachloroethylene imports were 119 million lb for 1988, 136 million lb for 1987, and 159 million lb for 1986 (Chem Prod, 1989). Tetrachloroethylene exports for those same years were 60 million, 54 million, and 45 million lb (Chem. Prod., 1989). Tetrachloroethylene imports exceeded 102 million lb in 1989 (USDOC, Imports, 1990). This represented a decrease from the 1988 total of 119 million lb (Chem Prod, 1989). Total tetrachloroethylene imports were 136 million lb and 159 million lb for 1987 and 1986, respectively (Chem Prod, 1989). In 1985, the United States imported 140 million lb of tetrachloroethylene and exported approximately 22 million lb (Chem. Week, 1986; USDOC Exports, 1986). Estimated 1984 United States imports were reported as 133 million lb, and exports exceeded 28.8 million lb (Chem. Prod., 1985c; USDOC exports, 1985). In 1983, 55 million lb were imported, and 54 million lb of tetrachloroethylene were exported (Chem. Prod. 1985c).

From 1980 to 1984, tetrachloroethylene demand declined by roughly 30%, and the present decline in demand is expected to continue through 1990 (Chem. Mktg. Rep., 1986a; Chem. Prod., 1985c). This decline in demand has been attributed to an increase in product recycling, rather than decreased product use (Chem. Eng. News, 1987b).

EXPOSURE

The primary routes of potential human exposure to tetrachloroethylene are inhalation and dermal contact, but the chemical is also absorbed after ingestion. About 85% of the tetrachloroethylene used annually in the United States is lost to the atmosphere. In 1974, this amount was estimated to be 550 million lb. Numerous studies have found tetrachloroethylene in the air in the United States at concentrations ranging from 30 ppt in rural areas to 4.5 ppb in metropolitan or industrial areas. Tetrachloroethylene may be formed in small quantities during chlorination of water. It has also been detected in rainwater, sea water, rivers, and subterranean water, and in commercial deionized charcoal-filtered water. Tetrachloroethylene has been found in foods, such as dairy products, meats, oils and fats, beverages, fruits and vegetables, and fresh bread, and in the tissues of fish, shellfish, marine mammals, and algae (IARC V.20, 1979; ATSDR, 1995k). The Toxic Chemical Release Inventory (EPA) listed 394 industrial facilities that produced, processed, or otherwise used tetrachloroethylene in 1996 (TRI, 1999). In compliance with the Community Right-to-Know Program, the facilities reported releases of tetrachloroethylene to the environment which were estimated to total 7.9 million lb.

Potential consumer exposure to tetrachloroethylene may occur through use of coin-operated laundromats containing dry cleaning machines and freshly dry-cleaned clothing. In a limited study, six coin-operated facilities in the Washington, DC, area were sampled. The highest 7-day average tetrachloroethylene level of 8,600 ppb was reported for the only air-conditioned facility where air was recirculated. The 7-day average values in the five facilities that were not air-conditioned ranged from 130 to 1,500 ppb. Since these values were 8-hr time-weighted averages (TWAs), much higher peak levels may have occurred (Howie & Elfers, 1981). In another limited study conducted by the Michigan Department of Public Health (1979) an average tetrachloroethylene concentration of 1,300 ppb was detected during the summer in four coin-operated laundry facilities in the counter area and breathing zone of the counter attendant. During the winter, average levels of 4,500 ppb and 3,500 ppb were measured in the counter area and breathing zone of the counter attendant, respectively. In one very limited study, the tetrachloroethylene levels were measured in the bedroom of one house in which freshly dry-cleaned clothing was hung in the closet for 1 week. Levels decreased from a high of 102 ppb on the first day of exposure to 6.2 ppb on the seventh day. The average level over the 7-day period was 29 ppb (Howie & Elfers, 1981).

The National Occupational Exposure Survey (1981-1983) indicated that 395,882 workers, including 129,221 women, potentially were exposed to tetrachloroethylene in the workplace (NIOSH, 1984). Approximately 200,000 dry cleaning establishments use tetrachloroethylene. Over half of the domestically consumed tetrachloroethylene is used for dry cleaning and one-quarter is used in fluorocarbon production; therefore, workers in these two industries account for most of the potential occupational exposure to tetrachloroethylene (Morgan et al., 1985; Chem. Eng. News, 1987b; NIOSH 20, 1978). An analysis of 44 dry cleaning establishments in the United States determined geometric mean TWA exposures ranging from 3.0 to 22 ppm (ATSDR, 1995k). NIOSH reported that nearly 500,000 workers in 1978 and 275,000 workers in 1979 potentially were exposed to tetrachloroethylene (NIOSH 20, 1978; NIOSHb, 1979d). The National Occupational Hazard Survey, conducted by NIOSH from 1972 to 1974, estimated that 1,597,072 workers were potentially exposed to tetrachloroethylene in the workplace (NIOSH, 1976).

REGULATIONS

CPSC is currently coordinating activities with EPA to address problems associated with tetrachloroethylene in the Chlorinated Solvents Integrated Strategy. EPA regulates tetrachloroethylene under the Clean Air Act (CAA), Clean Water Act (CWA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Food, Drug, and Cosmetic Act (FD&CA), Resource Conservation and Recovery Act (RCRA), and Safe Drinking Water Act (SDWA). Tetrachloroethylene is a toxic pollutant of air, a pollutant of water with carcinogen and oncogen designations, and a hazardous waste. Effluent guidelines, standards of performance, and water quality criteria have been published. A reportable quantity (RQ) of 1 lb was established for tetrachloroethylene under CERCLA and CWA. The RQ was adjusted from 1 lb to 100 lb. Tetrachloroethylene is exempted under FD&CA from tolerances for pesticide chemicals. FDA regulates tetrachloroethylene as an indirect food additive. NIOSH has recommended to set the REL for tetrachloroethylene at the lowest feasible concentration. OSHA established a transitional permissible exposure limit (PEL) of $\leq$ 100 ppm as an 8-hr TWA, and a 200-ppm ceiling not to exceed 300 ppm for over 5 minutes in 3 hr. The OSHA final rule adjusted the PEL to 25 ppm with no STEL or ceiling permitted. OSHA also regulates tetrachloroethylene under the Hazard Communication Standard and as a chemical hazard in laboratories. Regulations are summarized in Volume II, Table B-137.